EVOLUTIONS, GENES, and BEHAVIOR

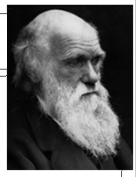
BIOLOGICAL BASIS OF BEHAVIOR

- **All biological organisms have evolved over millions of years,**
- **Also, environmental factors have played an important role in shaping the organization and function of their nervous system.**
- **The evolutionary change = *Natural Selection* (Charles Darwin) = important role in shaping both behavior and brain.**
- **GENE**
- **EVOLUTION**

Darwin's Theory of Evolution

- **Modern biology began in 1859 with the publication of Darwin's *"On The Origin of The Species"* describing the <u>Theory of Evolution.</u>**
- **Species evolve (undergo gradual orderly change) from preexisting species.**
- **Darwin was NOT the first to propose this idea, but he was the first to <u>provide strong evidence</u> to support his idea**

Darwin's Theory of Evolution



- **Evolution occurs through "natural selection"**
- **Natural selection = mechanism by which evolution takes place**
- **Fitness = the ability of an organism to survive and contributes its genes to the next generation.**
  - **An organism with high rates of survival and reproduction will pass on its genes to the next generation**

Evolution of Behavior

- **Proximate causes of behavior (HOW)**
  - **such as the firing of special motor neurons to contract the muscles.**
  - **How a behavior is generated. Nervous system, hormones, brain function etc.**
- **Ultimate causes (WHY)**
  - **behavior in its evolutionary context.**
  - **Why we need this behavior.**
- **Sexual selection**
  - **aspects of *natural selection* that yields traits that promote reproductive success**

Evolution of Behavior

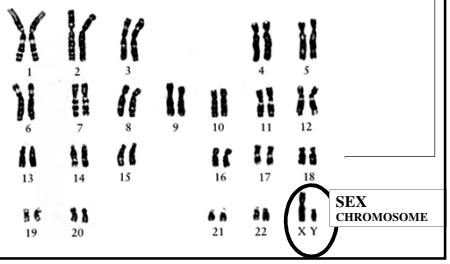
- **Early studies of evolution focused on structure**
- **Behavior also plays an important role in determining an organism's fitness**
- **The contribution of some behaviors** (e.g. eating, sexual beh, predatory beh) **are obvious. Others may be less obvious but very important**
- **One example is Social Dominance**

SOCIAL DOMINANCE

- **Males establish "hierarchy of social dominance" by combative encounters with other males**
- **Social dominance influences evolution because dominant males (or females) are able to copulate more**
- ***McCann* (1981) found that the highest ranking bull accounted for 37% of copulation, the 2nd rank was for 19%,…. the lowest ranking was for only 1%**
- **An organism with high rates of survival and reproduction will pass on its genes to the next generation**

Chromosomes and Genes

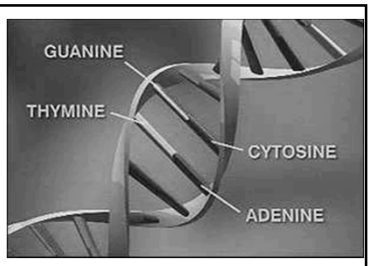
- **Chromosomes**
  - structure in the nucleus of each cell in the body. Most body cells contain **46 chromosomes**: 23 from father's sperm, 23 from mother's ovum
  - Each chromosome is a DNA molecule



DNA

DNA (De-oxy-ribo-Nucleic Acid).

The chemical that all life uses for long-term storage of genetic information. Your **genes** are made of DNA. A **chromosome** contains one enormously long DNA molecule.

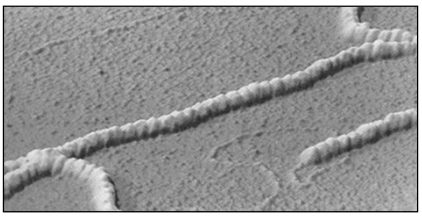


A DNA molecule is often diagrammed as a spiral ladder. The cross-arms are made of the *nucleotide bases* Adenine, Cytosine, Guanine, and Thymine (A,C,G,and T) attached to a chain of phosphate and deoxyribose. Specifically, there are four possible cross-arms: AT, TA, GC and CG.

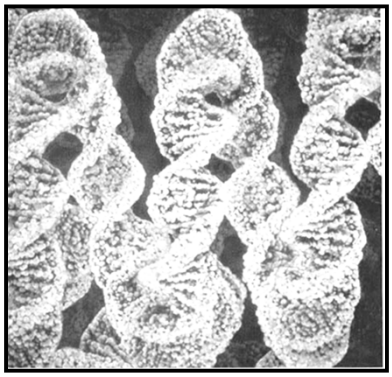
mes Watson and Francis Crick
1953, Cambridge, UK

GENE

- Each chromosome is a DNA molecule
- Gene is on chromosome
- Each gene on a chromosome is either a whole molecule of DNA or a part of one
- DNA = Deoxyribonucleic Acid



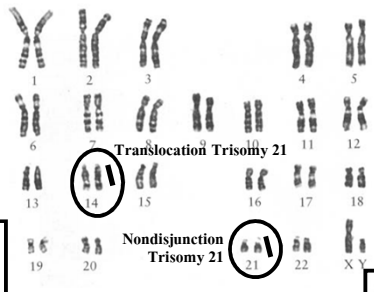
A scanning electron microscope image of DNA molecules



A photomicrograph of deoxyribonucleic acid (DNA).

TABLE 4–2 Risk of Giving Birth to a Down Syndrome Infant by Maternal Age

MATERNAL AGE	FREQUENCY OF DOWN SYNDROME INFANTS AMONG BIRTHS
30	1/885
31	1/826
32	1/725
33	1/592
34	1/465
35	1/365
36	1/287
37	1/225
38	1/176
39	1/139
40	1/109
41	1/85
42	1/67
43	1/53
44	1/41
45	1/32
46	1/25
47	1/20
48	1/16
49	1/12



Translocation Trisomy 21

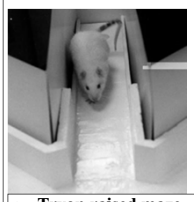
Nondisjunction Trisomy 21

Mosaic Trisomy 21 = Not all cells have extra chromosomes

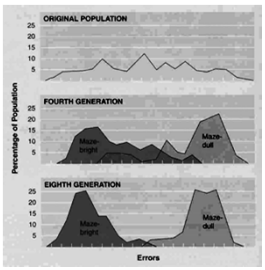
Chromosome abnormality = behavior problem

Genetic Studies and Behavior

- **Selective breeding**
  - animals that are high or low in a certain behavior or physical trait are mated with each other



- **Tryon raised maze-bright and maze-dull rats**



Genetic Studies and Behavior

- **Twin studies**
  - Study a group of monozygotic, dizygotic twins
  - Behavior genetics
  - Combines the methods of genetics and psychology to study the inheritance of behavioral characteristics
  - measuring a behavioral attribute of a group of subjects (e.g., IQ) and ask what proportion of the variation among the subject resulted from genetic differences as opposed to environmental differences
  - How many part of that behavior (e.g., IQ) is influenced by genetic / how many part is influenced by environment?

The Minnesota Study of Twins Reared Apart

Participants:

1. **59 pairs of identical twins and 47 pairs of fraternal twins who had been reared apart**
2. **Many pairs of identical and fraternal twins reared together**

Behavior Measures:

- **IQ**
- **Personality traits**

- **Heritability Estimate of IQ = 0.7**
- **The more genes you share, the high probability you might have similar IQ level.**

The Minnesota Signal, Tuesday, November 19

Twins prove intelligence and personality inherited

Bob and Bob don't know each other. But they were born on the same day, graduated with engineering degrees in the same year, and both married teachers named Brenda. They both wear glasses, have mustaches, and smoke a pipe.

Bob and Bob are 38-year-old identical twins who were separated by adoption shortly after birth.

Dr. Thomas Bouchard and his colleagues recently brought Bob and Bob and 55 other pairs of genetically identical twins reared apart to the University of Minnesota.

Each twin underwent 50 hours of intensive psychological testing.

Dr. Bouchard found that the pairs of twins were almost identical in their intelligence and personality, despite having been reared by different families.

These findings are spearheading a psychological revolution.

They show that intelligence and personality are mostly genetic rather than being the result of experience, as thought by most psychologists.

The heritability estimates for IQ were found to be 70.

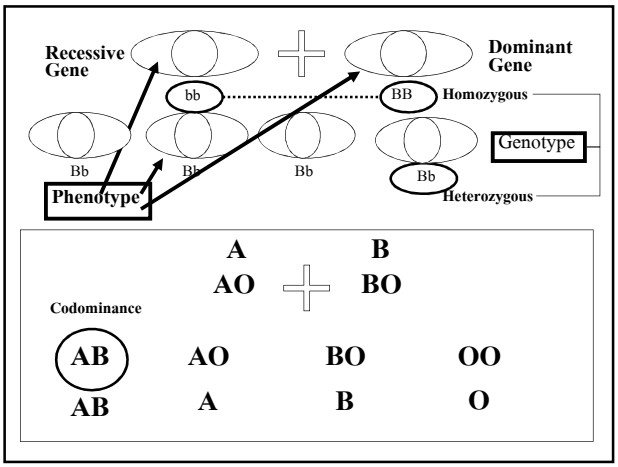
Nancy Baynes, chairperson of the school board, when contacted said, "We will certainly be discussing the implications of these important findings at our next meeting."

Genetic Studies and Behavior

- **Molecular genetics**
  - influence of specific genes on personality, and other specific behavioral traits
- **Environmental influences on gene action**
  - role of environment and interaction in manifestation of a behavior or particular disorder
  - Ex. Schizophrenia is hereditary (gene)
  - The chance to develop Schizophrenia depends on environmental factors
  - Genes may predispose a person to Schizophrenia, but the environment in which he or she grows up shapes the actual outcome **(Reaction range)**

Genetic Principles

- **Dominant - Recessive Gene**
- **Codominance**
- **Polygenic Inheritance**
- **Genotype - Actual genetic material**
- **Phenotype - Expression of genotype**



EVOLUTIONS, GENES, and BEHAVIOR

- From an evolution and functional point of view, any behavior that is *adaptive* (needed, important for survival of the species) will pass to the next generation.
- It confers *reproductive success*.
- Reproductive success promotes the perpetuation of genes that control that behavior